Karlsruhe Institute of Technology

SMART DATA - DEALING WITH TASK COMPLEXITY IN CONSTRUCTION SCHEDULING

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Svenja Oprach *(presenting author)*, Dominik Steuer, Viktoria Krichbaum, Shervin Haghsheno

Institute of Technology and Management in Construction

Target

Just 1% of all documented data is used in further projects

(Burn-Murdoch 2012)

This is not a LEAN process.

99% of our construction data is waste.

WHY???

Used Method: Value Stream Management

- Selection of a topic: **TIME SCHEDULING**
- Collection of data
- Visualization of the current state

Value Stream Mapping

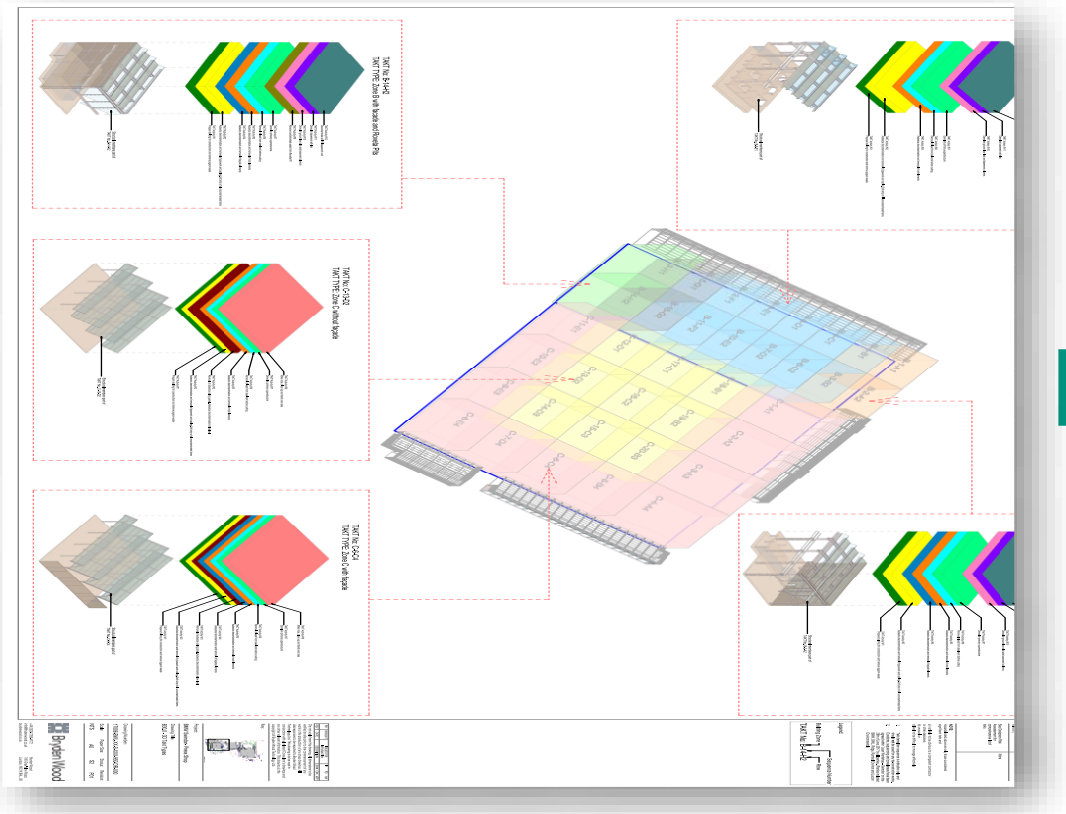
- Creating a roadmap for the implementation
- Continuous improvement by iterative steps

Value Stream Planning

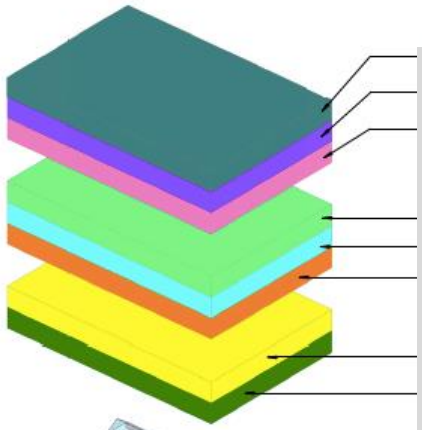
- Starting with a white sheet and development of a visionary state

Value Stream Design

Smart data in a real-world construction project

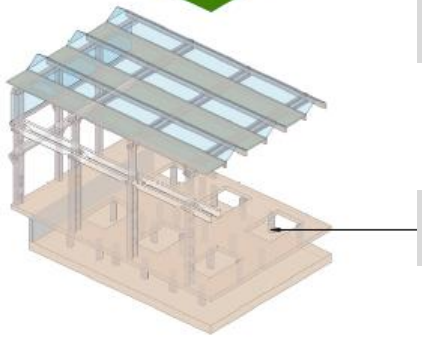


INFORMATION STACK



List of tasks in sequence with **process features**:

- Work packages
- Durations
- Operationally significant location



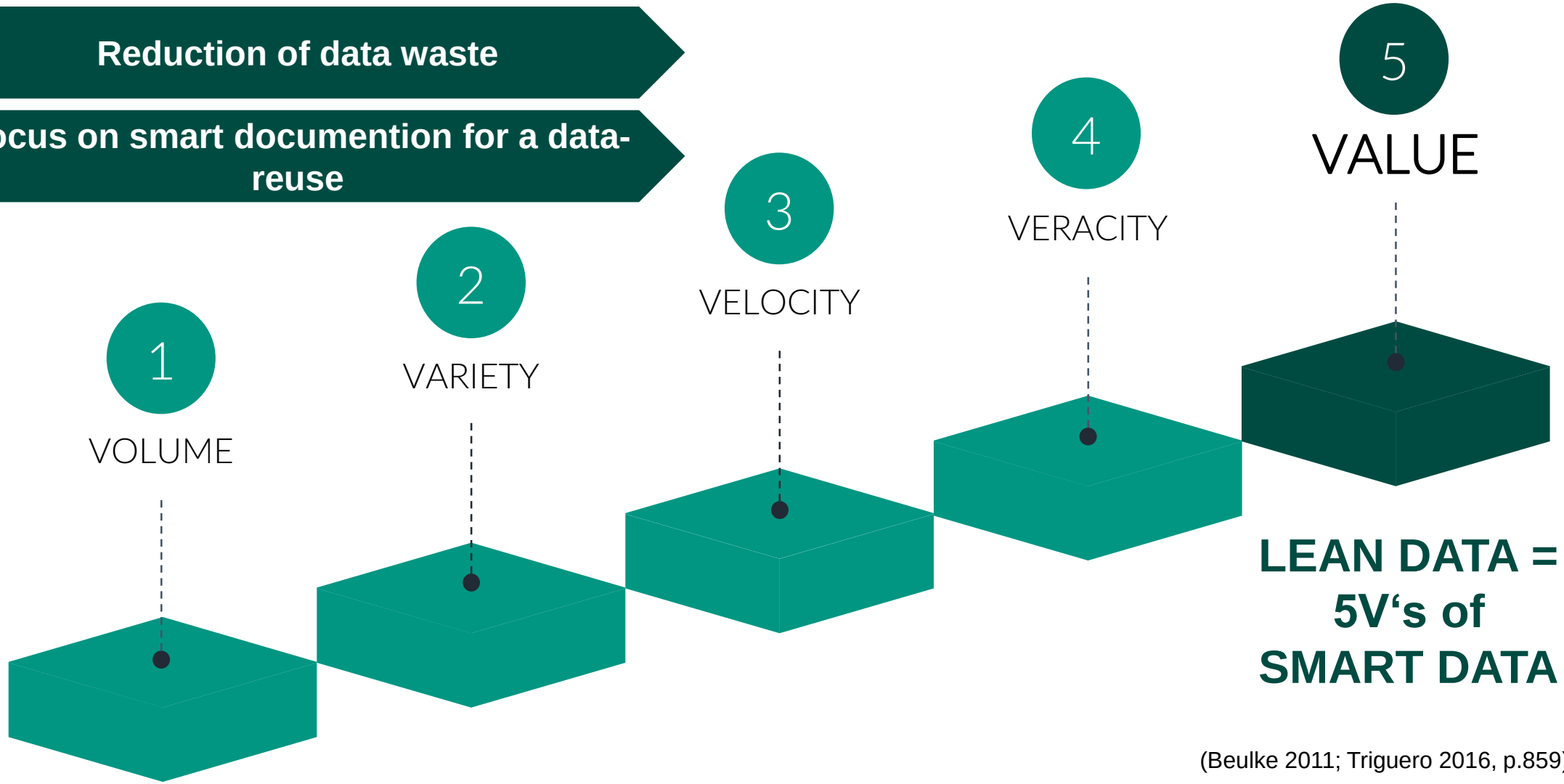
Product features

Information construction stack: According to Siami-Irdemoosa et al. 2015, p. 88; Makarfi Ibrahim et al. 2009, S. 389

What is Lean Data Management?

Reduction of data waste

Focus on smart documention for a data-reuse



LEAN DATA = 5V‘s of SMART DATA

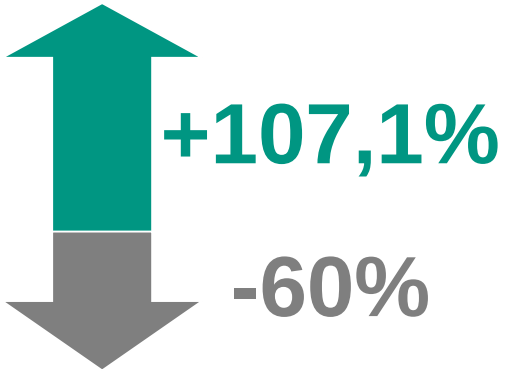
(Beulke 2011; Triguero 2016, p.859)

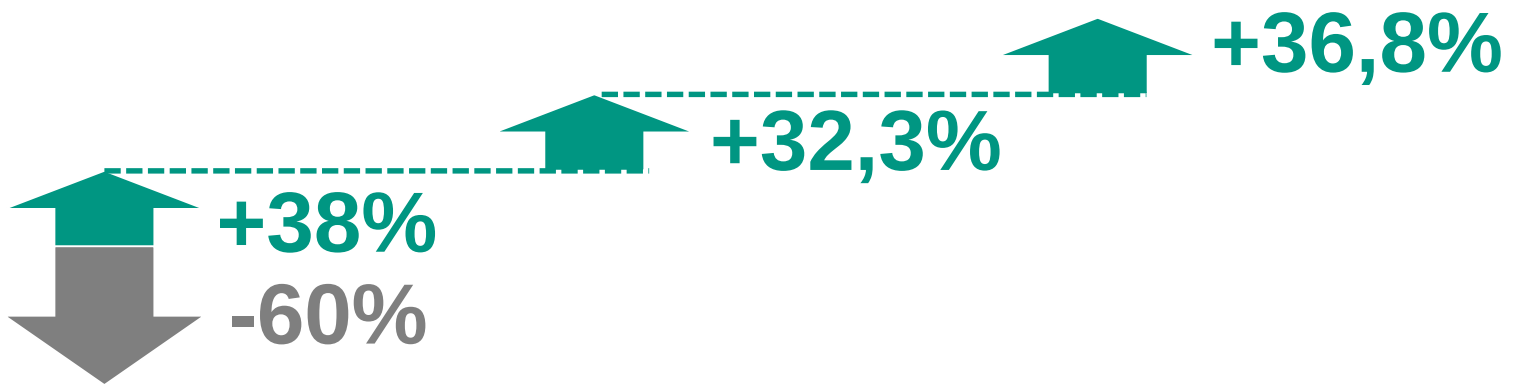
The work packages can vary in naming and detail level

First Fix ELT	Second Fix ELT
Electrical installations I	**ELT Installations, Light fixture**
ELT Cable duct	**ELT-Final installation**
ELT Assembly/Installation of trays	**Lights/Sockets**
Wiring	**ELT Precision assemblies**
Basic installation electro	

Table 1: Example of work package naming of the electrician in 66 construction projects

The activity duration can vary strongly





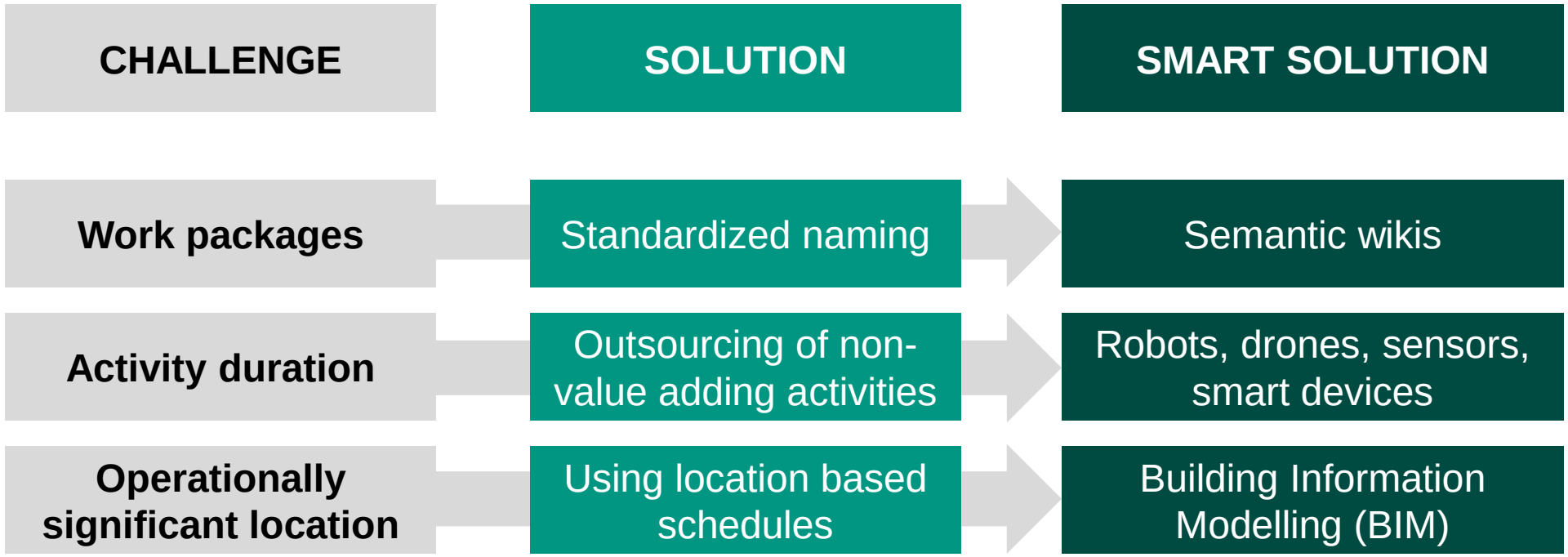
Individual performance (LMS)		MUDA 1		MUDA 2	
Skills	**-22% to**	**Transports**	**0% to +19,8%**	**Disturbances**	**0% to +3,5%**
Effort	**-17% to**	**Ways**	**0% to 5,6%**	**Personnel stops**	**0% to +10,3%**
Consistency	**-4% to +4%**	**Searching**	**0% to 1,1%**	**Absence**	**0% to +8,9%**
Conditions	**-7% to +6%**	**Cleaning &**	**0% to 5,8%**	**Others**	**0% to +14,1%**
Sum	-60% to +38%	Sum	0% to 32,3%	Sum	0% to +36,8%

LMS = Lowry, Maynard and Stegemerten; Additional time for individual performance and non-value adding activities (Karger, p. 31; Boenert and Bloemeke 2013)

The operationally significant location is often not documented

Source: https://www.matchware.com/examples/gantt-chart/construction-project-plan/559

Possible solutions for time scheduling with smart data



Conclusion

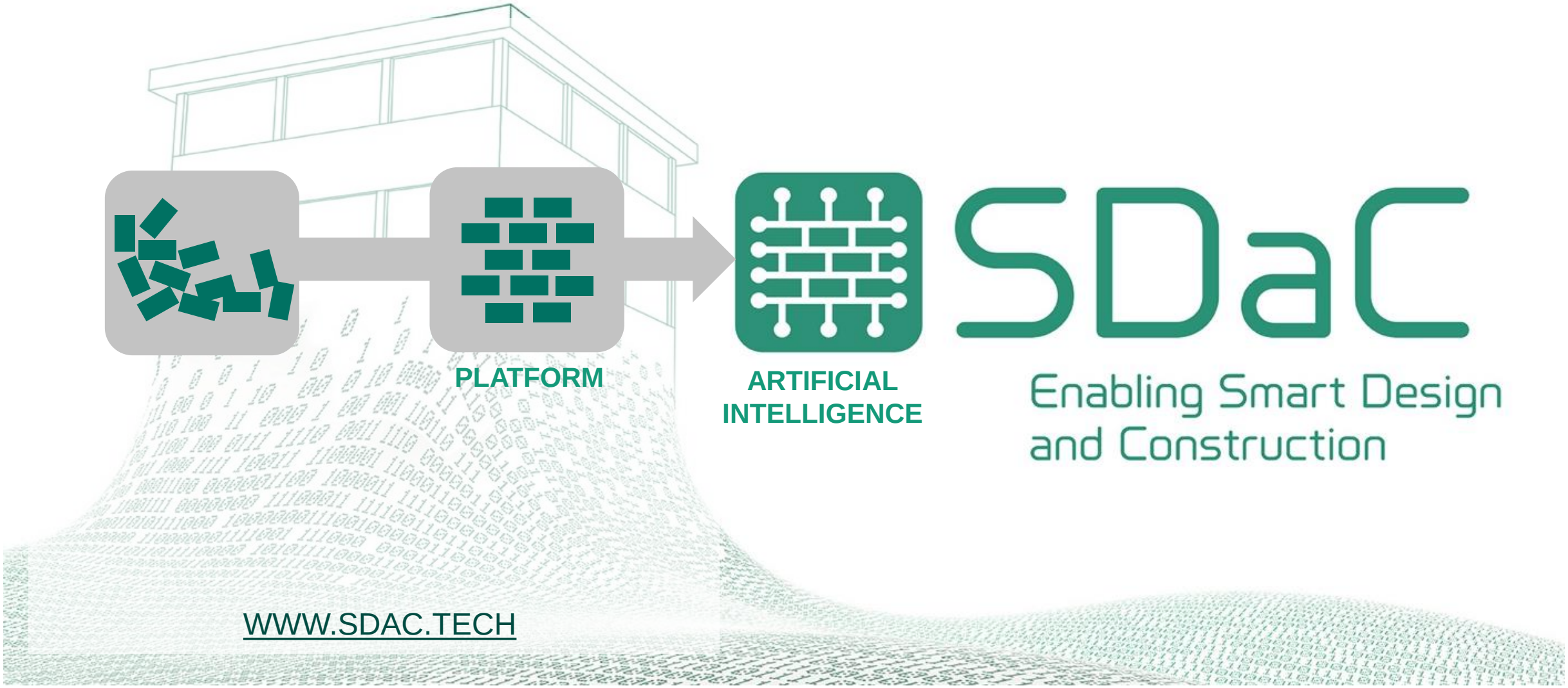
01 In **Construction Data Management** exists a lot of data waste

02 **Lean Data = 5V's of Smart Data**

03 The **existing complexity** in the construction task is shown in work packages, duration and location

04 For cross-company smart solutions there needs to be further research investigated

Outlook – Research project



References

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Work packagaes

Standardization of work package naming is a possible solution, with this possible the most possible sequences can be analyzed (Traeger 1994, p. 14).

No.	Premises	Conclusion	Confide...
40	Dachdecker	Elektro, Fensterbauer, Aufzugsbauer, Erdbauer	0.200
68	Fensterbauer	Elektro, Aufzugsbauer, Erdbauer	0.250
84	Windows	Electrician, roofing, lift	0.25
111	Aufzugsbauer	Elektro, Erdbauer	0.333
128	Aufzugsbauer	Elektro, Fensterbauer, Erdbauer	0.333
144	Aufzugsbauer	Elektro, Dachdecker, Fensterbauer, Erdbauer	0.333
170	Erdbauer	Elektro	1
190	Erdbauer	Elektro, Aufzugsbauer	1
192	Aufzugsbauer, Erdbauer	Elektro	1
244	Erdbauer	Elektro, Fensterbauer, Aufzugsbauer	1
246	Fensterbauer, Erdbauer	Elektro, Aufzugsbauer	1
247	Aufzugsbauer, Erdbauer	Elektro, Fensterbauer	1
249	Fensterbauer, Aufzugsbauer, Erdbauer	Elektro	1
344	Erdbauer	Elektro, Dachdecker, Fensterbauer, Aufzugsba...	1

In **25%** of all analyzed construction projects if windows were installed, in advance there were electrician, roofing and lift works.

For international and a cross-company comparisons **semantic wikis** must be established.

Example of sequential pattern mining in RapidMiner with expected trades in a construction project

Literature review – Defining the existing complexity

1. Partially oberservable tasks
2. Deterministic, but seems stochastic
3. Sequential tasks
4. Dynamic environment
5. Constant tasks
6. Unknown tasks
7. Multiagent environment

(According to Norvig p. 69-72)

The work packages can vary in naming and detail level

1 Partially oberservable tasks

6 Unknown tasks

7 Multiagent environment

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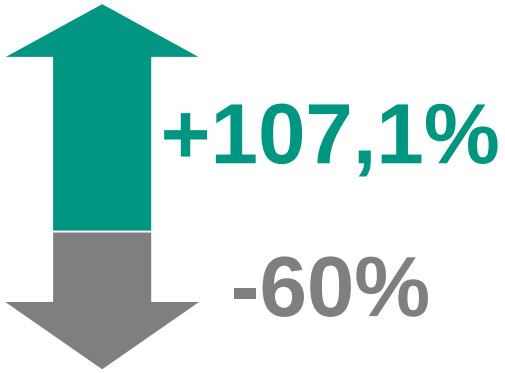

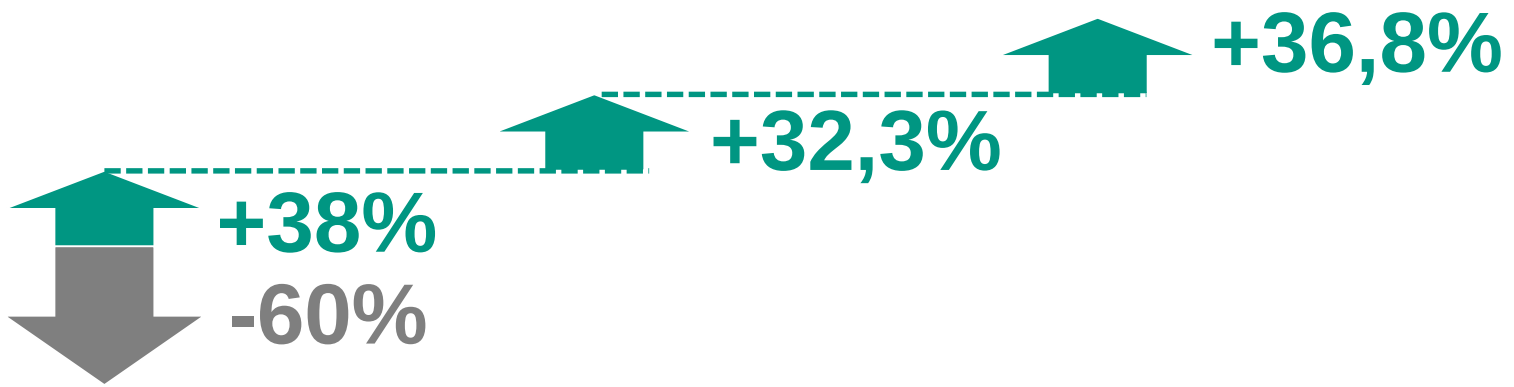

2 Deterministic, but seems stochastic

3 Sequential tasks

4 Dynamic environment

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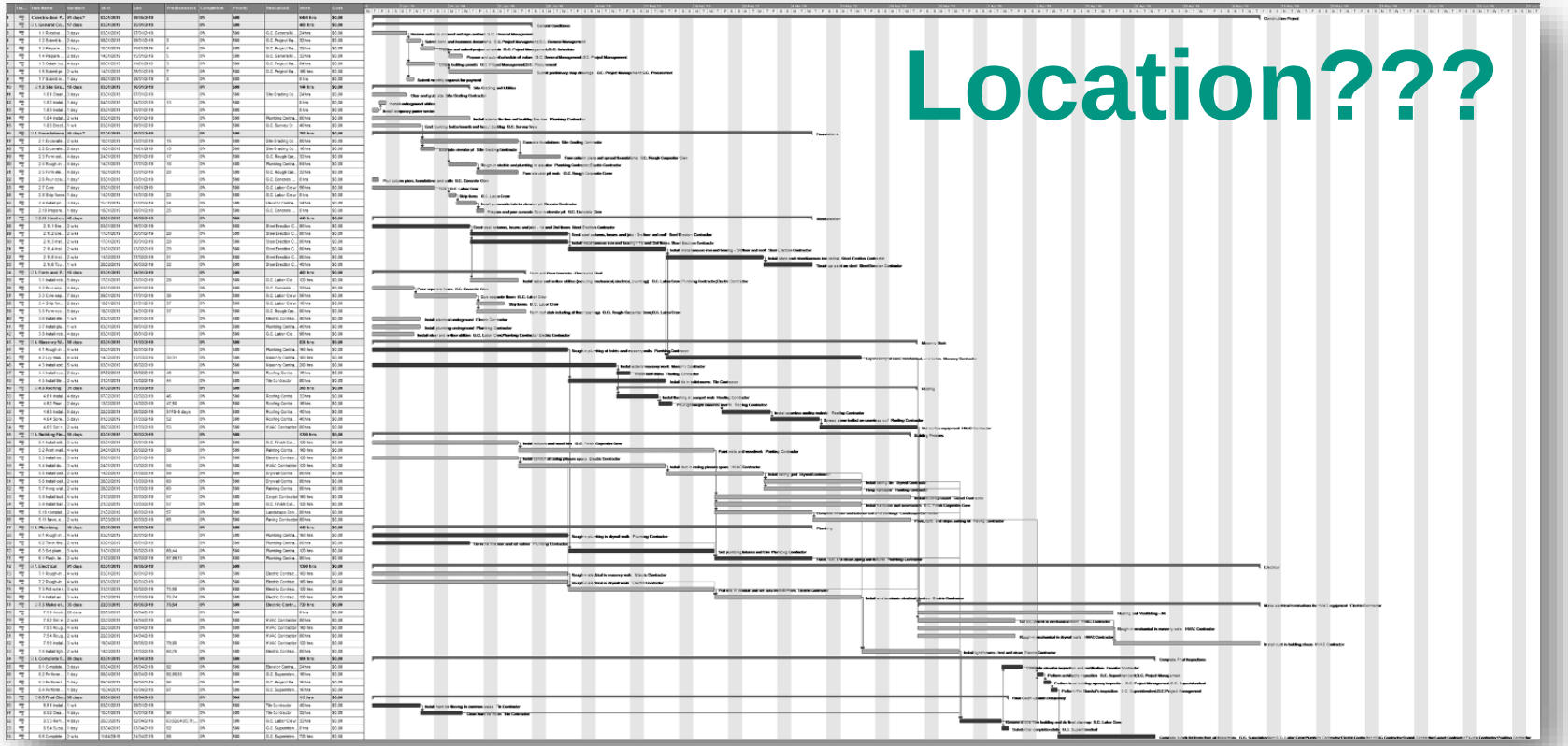

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7 Constant tasks